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Final Reports #12

FOOD WASTE RECYCLING PLANT

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INDUSTRIAL WASTE DIVERSION PROGRAM

FINAL REPORTS # 12

FOOD WASTE RECYCLING PLANT

Report Prepared For:

Waste Management Branch
Ontario Ministry of the Environment

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FOOD WASTE RECYCLING PLANT

Report Prepared For:

Waste Management Branch
Ontario Ministry Of The Environment

In Consultation With:

Ontario Research Foundation

Report Prepared By:

Peter J. Top
Biotechnology & Chemical Engineering Centre
Energy & Environment Engineering Division

DISCLAIMER

This report is in partial fulfillment of conditions of a grant given to By-Products Inc. by the Ministry of the Environment under the Industrial Waste Diversion Program. The report was prepared by Peter J. Top of the Ontario Research Foundation for By-Products Inc. and documents results of work for which the Ministry of the Environment provided financial assistance.

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EXECUTIVE SUMMARY

This report was prepared on behalf of By-Products Inc., a Mississauga based company that wished to establish a recycling facility for packaged food goods. Of primary concern is whether sufficient waste of this nature would be available for reprocessing, and whether the generating plants would be likely to use a recycling facility as an alternative to disposal. To answer these and other questions, a short mail survey was conducted among the food processors in the region. The response, while not overwhelming, can, nonetheless, be interpreted as to suggest that there is a need for a facilty such as that proposed by BPI.

Investigated in the study are the sources of raw material, markets for the various recyclable fractions and the pertinent legislation governing these activities. It is recommended that a facility be constructed in phases, beginning with a plant capable of processing dairy food wastes. This can then be expanded to include other waste types, as BPI gain a better understanding of the business.

Peter J. Top
Waste Treatment Technology
Energy & Environmental Engineering Division

Approved by:

Brian Forrestal, P.Eng.
Manager, Waste Treatment Technology
Energy & Environmental Engineering Division

PJT/BF/id

1. INTRODUCTION

In today's industrial society, when a waste disposal problem is mentioned, one immediately thinks of hazardous wastes. No doubt toxic and radioactive wastes are more dangerous and newsworthy than food wastes. Nonetheless, the sheer volumes and treatment needs associated with food waste demands that it receive more attention than is happening at present. Food processors produce a significant amount of waste. Whether they are generated from production or packaging problems, product spoilage, or expired shelf life, these wastes must be disposed of in an environmentally and economically sound fashion. Since food wastes are biodegradable, landfilling or sewering may seem like the appropriate solution. This solution is rejected for two reasons, the first being the cost of disposal, and the second, the loss of valuable resources.

The first problem is the high cost of using landfills and sewage treatment plants. As current landfill capacity is being quickly exhausted and the identification and acceptance of new landfill sites becomes virtually impossible, landfill owners have resorted to large increases in tipping fees to discourage unnecessary use of landfills and, hopefully, promote recycling. Food wastes decompose quite rapidly to produce offensive odours and contribute significantly to both the volume (since food has a high moisture content) and BOD (biochemical oxygen demand) of the landfill leachate. A look at landfill tipping fees in the Toronto region shows how serious the waste disposal crisis has become. As shown in Table 1.1, fees at Toronto's Keele Valley site went from $13.24/metric tonne in 1984 to $18.07/metric tonne in 1987. On May 1, 1988, a further increase of 177% to $50/metric tonne ($65/metric tonne at transfer station) will come into effect.

Similarly, the Region of Halton's price went from $18/metric tonne to $36.50/metric tonne between 1984 and 1987. By June, 1988, it is expected to be $50/metric tonne. Situations like these are occurring in municipalities throughout the province.

Sewer rates show similar trends. Many Ontario regions now impose a surcharge on those industries with high volume discharges and where contaminant concentrations exceed acceptable levels. For most regions, the acceptable BOD concentration ranges from 300 to 500 mg/L. The surcharge is usually the treatment cost multiplied by a correction factor. For instance, the Region of Peel's surcharge rate is:

$$\text{Surcharge} = F \times Q \times R$$

where F = [BOD - 500]/500
Q = Flow
R = Treatment rate = $0.418/kg

The BOD of foods commonly ranges from 50,000 mg/L for fruit drinks to as high as 650,000 for ice cream. With BODs this high, sewer bills can become a significant cost to a food processor. Through the use of these surcharges, the regional municipalities hope to discourage the sewering of high BOD wastes completely. Indeed, the Region of Peel expects to eliminate the surcharges by 1990 and, instead, rigidly enforce its discharge limits. This should encourage waste generators to investigate more imaginative alternatives to disposal, such as reduction, recovery and recycle, followed by treatment of the final waste stream prior to sewer discharge.

The expensive waste management practice of landfilling becomes even more impractical for recoverable waste materials such as plastics, glass, metal, paper and food, most of which have the potential to realize a cost saving for the generator with a little extra effort. To recycle aluminum scrap consumes about 5% of the energy required to produce it from the raw bauxite. Crushed, recycled glass is added when manufacturing new glass to increase heat gain and lower fuel costs. Plastics are derived from petroleum, an expensive non renewable resource.

By-Products Inc. (BPI) is a Mississauga based company whose operations include cleaning tank trucks and totes for the food and chemical industry. Tank residues are recovered for reuse whenever possible. Their experience in this business has led them to recognize the food processor's need for alternatives to landfilling and sewering. BPI is proposing to establish a facility that would accept non-salable food products and their accompanying packaging for segregation into their various components for eventual recycle or reuse off-site. Plastics, foils, and paper products would be bulked and sent (possibly sold) to the appropriate recycling facilities, while the food portion would be directed towards reuse as animal feed. The benefits of such a facility include the following:

- It would reduce the volume of materials being disposed of in landfills
- It would help reduce the BOD loading in landfill leachate
- It would help reduce the BOD load entering the sewers and sewage treatment plants

- It would promote increased reclamation of materials such as plastics, aluminum, paper and glass
- It would produce a high quality animal feed from materials that are presently landfilled
- It would provide food processors with an economical alternative to disposal.

While the advantages of such a facility, from an environmental perspective, are clear, there are, nonetheless, a number of areas which need further investigation in order to justify the construction and operation of the proposed plant by the private sector. Thus, the purpose of this study is to provide information for a realistic and achievable business plan.

TABLE 1.1 - Landfill Disposal Fees in Selected Areas Across Ontario (Varangu, 1987)

	Cost per metric tonne		
Locality	1984 ($)	1987 ($)	1988 ($)
Brantford	0	12.00	
Essex/Windsor	14.00	27.00	
Guelph	0	14.60	
Halton	18.00	36.50	53.58
Hamilton/Wentworth	20.00	27.00	
Kitchener/Waterloo	7.95	14.43/17.05	
Peel	12.60/13.50	19.00/34.50	50.00
Steetley (Private Landfill)	0	20.00	28.50
Toronto	13.24/15.50	18.07	50.00

2. WASTE GENERATION DATA COLLECTION

2.1 Introduction

There were 953 food manufacturing operations (excluding meat processing) in Metropolitan Toronto and its vicinity in thirty-eight different four-digit SIC industry product sub-sectors in 1986. Often, a number of manufacturing operations take place in a single plant producing a number of different products. The activity of the food industry in each product sub-sector is summarized in Table 2.1.

Although the company selection process was random, emphasis was placed on the inclusion of companies with more than thirty employees and located in Mississauga, Oakville or the west end of Toronto. This was because BPI is proposing to build its facility in Mississauga, and transportation distances will be a significant cost factor in collecting the waste products. An additional three food retail and distribution facilities (i.e. non-manufacturing) were also included in the survey to estimate the quantities of food products discarded from this large food handling industry.

Companies and appropriate contacts were identified using both Scott's Trade Directory, 1987-88, and personal contacts.

2.2 Questionnaire

In order to establish the quantities and types of waste being generated in the area, a 4-page questionnaire was designed (see Appendix A). Information was solicited on the types of food products made, and on if, and how the proposed facility would be of use to each company. Companies were also requested to complete a detailed profile of each of the waste products generated, in terms of volume, packaging, and current collection and disposal practices.

2.3 Mailing

A letter of introduction was sent to each company, addressed to a specific individual (normally plant manager), requesting participation in the survey (see Appendix A). It also outlined the project objectives and addressed the often sensitive issue of confidentiality of information. We undertook not to report specific data which might identify a particular waste producer. The letter also suggested that a visit to the plant for a personal interview would be possible if required.

The questionnaires were mailed out during the second week of January, 1988.

2.4 Response

At the beginning of February, all those companies which had not responded to the mailing were contacted by telephone. The final participation rate in the survey was 9 companies or 24.3 percent (see Table 2.2). Six of the thirty-seven plants were visited to view their operations. Only one of these visits was at the request of the company. One company refused to discuss any aspect of its waste management practices with us. Many companies discussed their waste management situations in general terms over the telephone, but failed to return a completed questionnaire.

The level of response to the survey was reasonable, but certainly not overwhelming. There are most definitely food processors in the Toronto area who are aware of, and concerned about the rising cost of waste disposal, and who would gladly welcome a cheaper alternative to landfill. The timing of the survey was somewhat unfortunate in that the increases in landfill costs to the $50 mark, which will occur in most areas this year, only made the newspapers after the survey was complete. Therefore, the impact of this large increase had little effect on survey results.

The data collected mean little in isolation and must be related to the industry as a whole, so that an estimate of the quantities of waste food products from the the entire Toronto area can be made. The number of companies operating in each of the food product sub-sectors in the Toronto area are listed in Table 2.1.

Within the thirty-seven manufacturing companies contacted, a total of seventy-four different manufacturing operations are used. This represents about 7.8% of the food product manufacturing operations in the region. However, 58% of the four-digit SIC groups were represented. The total quantity of waste generated by the nine companies that responded was 5,725 tonnes per year. These nine companies have twenty-six manufacturing operations, which represent about 2.8% of the total number of manufacturing operations in the area.

Since emphasis was placed on including some of the larger food processors, the average quantity of wastes generated by these companies should be somewhat greater than the average generated by the industry as a whole.

TABLE 2.1 - Food & Kindred Products' Manufacturers in Metropolitan Toronto and Vicinity

SIC	Product Sub-Sector	No. of Companies	Surveyed Companies Involved in Sector	Respondent Companies Involved in Sector
2017	Poultry & Egg Processing	59		
2021	Creamery Butter	8	2	2
2022	Cheese, Natural & Processed	19	2	2
2023	Condensed & Evaporated Milk	6	2	2
2024	Ice Cream & Frozen Desserts	13	4	3
2026	Fluid Milk	17	6	4
2032	Canned Specialties	22		
2033	Canned Fruits, Vegetables, Preserves, Jams & Jellies	43	7	2
2034	Dried & Dehydrated Fruits & Vegetables, & Soup Mixes	30	4	1
2035	Pickled Fruits & Vegetables, Vegetable Sauces & Seasonings, & Salad Dressings	36	1	1
2037	Frozen Fruits, Fruit Juices & Vegetables	11	4	1
2038	Frozen Specialties	30		
2041	Flour & Other Grain Milk Products	18		
2043	Cereal Breakfast Foods	18	1	
2044	Rice Milling	3		
2045	Blended & Prepared Flours	17	3	1
2046	Wet Corn Milling	6		
2047	Dog, Cat & Other Prepared Food	15		
2048	Prepared Feeds & Feed Ingredients for Animal & Fowl (n.e.c.)	12		

Contd.....

Table 2.1 Contd.

SIC	Product Sub-Sector	No. of Companies	Surveyed Companies Involved in Sector	Respondent Companies Involved in Sector
2051	Bread & Other Bakery Products Excluding Cookies & Crackers	152	1	
2052	Cookies & Crackers	43	3	1
2062	Cane Sugar Refining	2		
2065	Candy & Other Confectionary Products	62	7	1
2066	Chocolate & Cocoa Products	11		1
2067	Chewing Gum	5		
2075	Soybean Mills	4	1	
2076	Vegetable Oil Mills, Except Corn, Cotton Seed & Soybean	3		
2077	Animal & Marine Fats & Oils	4		
2079	Shortening, Table Oils & Other Edible Fats & Oils (n.e.c.)	19	1	
2082	Malt Beverages	7		
2083	Malt	3		
2084	Wine, Brandy, Spirits	3		
2085	Distilled, Rectified & Blended Liquors	12		
2086	Bottled & Canned Soft Drinks, & Carbonated Waters	27	4	1
2087	Flavouring Extracts & Flavouring Syrups (n.e.c.)	54	4	1
2095	Roasted Coffee	20		
2098	Macaroni, Spaghetti, Vermicelli & Noodles	17	1	
2099	Food Preparatives (n.e.c.)	123	5	2
	Retail Store Distribution Centre			1

TABLE 2.2 - Analysis of Survey Response

Toronto Region:	
No. of food manufacturing operations in Toronto region (excluding meat and fish processing)	953
No. of 4-digit SIC product sub-sectors represented	38
Survey Data Base:	
No. of food manufacturing companies contacted	37
No. of food manufacturing operations represented	74
% Toronto Region	7.8
No. of 4-digit SIC product sub-sectors represented	22
% Toronto Region	58
Survey Respondents:	
No. of food manufacturing companies that responded	9
% Surveyed	24.3
No. of food manufacturing operations represented in response	27
% Toronto Region	2.8
% Surveyed	35
No. 4-digit SIC product sub-sectors represented in response	16
% Toronto Region	42
% Surveyed	72.7
No. of non-manufacturing companies surveyed	3
No. of non-manufacturing companies responded	1

3. SOURCES OF WASTE FOOD PRODUCTS

3.1 Introduction

Food wastes may be defined as the edible portion of the wastes arising from the processing, packaging, tranportation, distribution and consumption of food. Thus, the main sources of materials for the proposed facility will be food processors, packagers, distributors and retailers. Primary targets will be the dairy, beverage, fruit and vegetable, confectionary and edible oil industries. Based on survey results, plant visits, discussions with food industry representatives and literature review, the current waste management practices and needs of each industry sector are discussed in the following sections.

3.2 Dairy Industry

The dairy industry was found to be the most enthusiastic about the proposed facility. Reasons for this were the volume and nature of the wastes generated. Typical wastes include fluid milk, ice cream and related novelty products.

Fluid milk has a shelf life of 14 days, after which most companies collect the expired or damaged milk product from the store shelves. One company landfills its entire load. Another segregates the milk products into usable milk (approximately half the milk collected), which it then reprocesses into ice cream or heavily salted cheese. The containers are manually opened, saving the usable milk and draining the remainder into a tank where it is collected by a pig farmer. Another company has recently invested in a press to squeeze this milk from the packaging. The milk drains to a tank and is collected, again by a pig farmer. Both companies dispose of packaging material to landfill. Generally, the farmer picks up the food waste free.

Although waste removal by individual farmers is economical for the dairies, it is not the most desirable of methods. As one company representative wrote, "it is not the most effective and reliable method of disposing of these bulk wastes. Your (BPI's) proposal makes more economic sense, as does your ability to reclaim additional product from packaging". A centralized collection facility would be able to offer a more reliable service to the processors, although they would have to pay for it. A study into food waste recycling concluded that the benefit to the farmer would be considerable and would reduce mortality rates and increase the food-waste-to-pork conversion ratio, significantly reducing production costs and increasing competitiveness (Price, A. T., et al, 1985).

In total, approximately 36,300 litres of milk is landfilled each week. Another 43,000 litres is collected by pig farmers (see Table 3.1). Other food items disposed of by the dairy industry are ice cream, cheeses, yogurt, cream and novelty items such as ice cream bars and sundaes. Approximately 700 litres/week of ice cream and 2,000 litres per week of other dairy by-products have been identified. The packaging material is varied. Fluid milk comes in three, 1-1/3 litre plastic pouches, in a plastic bag. It also comes in coated cartons in 250, 500 and 1,000 millilitre sizes. Dairy by-products come in coated paper and high density polyethylene (HDPE) tubs.

3.3 Fruit and Vegetable Industry

The fruit and vegetable industry would also benefit from a food waste recycling facility. An excellent example of this is the Ontario Food Terminal Board. It expects to send about 8,000 tonnes of waste to landfill this year. With the increase in landfill fees, waste disposal costs in excess of $500,000 for the upcoming fiscal year are predicted for landfilling alone.

It is estimated that up to 70% of this waste is food. Of the total quantity disposed, 40% is still on pallets. The remainder is loose waste which is collected in totes and emptied into a compactor. The amount of recoverable waste, which could potentially be recycled through BPI, ranges from a low of 43 tonnes per week, all of which is on pallets, to a maximum of 108 tonnes per week. A reasonable estimate of what could be recovered would be the palletted material, plus half the unpalletted food which equals 75.6 tonnes a week. The food is a broad array of fruits and vegetables such as potatoes, cabbage, lettuce, carrots, cucumbers, melons, apples, etc. The most common reason for the disposal of palletted produce is that it is considered too wilted to survive shipment to consumers. Packaging for the produce includes cardboard boxes, wooden crates, paper bags and plastic netting. Much of this waste would be available in large homogeneous shipments, which would be easy to segregate.

Warehouses for large chain food stores indicated that they dispose of produce wastes to landfill, as do their retail outlets. However, this waste volume was not quantified. Also, a fresh vegetable processor indicated that they are sending about 1.4 tonnes of vegetable trimmings to landfill each week and expect this quantity to more than double in the next year. With a waste disposal bill approaching $80,000 envisaged for 1988, they would welcome a more cost effective alternative to landfill.

3.4 Beverage Industry

The beverage industry also disposes of large volumes of packaged wastes. Although neither of Toronto's two major soft drink bottlers responded to the survey, background information indicates up to 0.5% of all canned beverage produced is waste disposed. This amounts to 1,000 tonnes annually of cardboard, tin, and aluminum, along with the beverage itself.

3.5 Bakery Industry

Bakery wastes make excellent animal feed. They also increase significantly the solids content of mixed waste streams. One cookie manufacturer estimates that between 1 and 10 tonnes per week are disposed of, with the average being 5 tonnes. In this particular case, the wastes are being picked up by a pig farmer.

3.6 Other Industries

Other waste sources include confectionary such as chocolate, pie fillings and edible oils. By-Product Inc.'s tank truck cleaning facility recovers approximately 9,000 litres per month of sugars (dextrose, sucrose, etc.) and 9,000 litres per month of vegetable oils.

Other more unusual sources of food wastes were also uncovered. For example, importers must pay duties on many goods brought into Canada. If, for some reason, they do not wish to accept delivery of their shipments, they can have Customs officers dispose of the goods and thereby avoid duty payments. Items disposed of in the past by Canada Customs include processed food, food produce, household chemicals, and pharmaceuticals (e.g. vitamins and mineral supplements). The LCBO also destroys spirits improperly imported. Such destruction must be attended by the appropriate officials. BPI could efficiently process these items, and recover the recyclable components. The non-recoverable fraction could then be sent to landfill. Environment Canada, Waste Management Branch, is currently looking into this problem to suggest alternatives to landfill disposal.

TABLE 3.1 - Current Fate of Food Wastes Reported

	Quantity Produced (Tonnes/week)			
Waste Food Product	Total	To Landfill	Sewered	Recycled*
Milk	79.3	36.3	-	43.0
Fruit and Vegetables (including Ontario Food Terminal)	1.4 (77.0)	1.4 (77.0)	-	-
Juices	10.0	-	2.0	8.0
Dairy By-Products - Yogurt, sour cream, etc.	7.4	7.4	-	-
Ice Cream	3.1	2.1	1.0	-
Cheese	0.5	-	-	0.5
Baked Goods	5.0	-	-	5.0
Vegetable Oils	2.1	-	2.1	-
Sugars (dextrose, glucose)	2.1			
Confectionary	0.6	0.6	-	-
Total (including Ontario Food Terminal)	187.1	123.4	7.2	56.5

*Primarily recycled into animal feed

4. PROCESSING OF WASTE PACKAGED FOODS

4.1 Segregation at Source

While together, the food and packaging material is effectively garbage, with no direct recycle value. In order to reclaim any value from this mixture, the components must be segregated.

The first stage of segregation must be done at source. Material worth recycling must be separated from that which is not worth recycling. The most efficient way to achieve this is to provide totes in the plant for the collection of recyclable material. These totes should be situated in the areas where the wastes are being generated. Food processing plants are usually designed along an assembly line approach, with each section performing one specific function, e.g. adding ingredients, inspection, packaging, etc. Consequently, specific wastes are produced in each of the processing areas, e.g. ingredient containers, off-spec food, unusable packaging, etc. Not only does this production system lend itself to the segregation of recyclable and non-recyclable materials, but it also assists with the segregation of the various recyclable fractions from each other. At present, many companies use totes to collect solid waste. However, they do not normally provide enough of them to adequately serve their facilities and do not restrict the types of wastes (i.e. recyclable, non-recyclable) deposited. However, with proper supervision and workers being informed of the importance of waste management, it should be possible to implement successful waste segregation programs in food processing plants. This has been accomplished in some of the dairy plants currently serviced by pig farmers.

The benefits of source segregation to the waste producers are several. First, properly segregated wastes would be picked up by BPI at prices lower than those charged by waste haulers. Wastes not properly segregated would continue to be sent to landfill. It should be remembered that the tipping fee is only a fraction of the waste haulers' costs. Depending on the service, it is estimated that 50% of the cost is the actual tipping fee, with the balance covering the haulers' costs and profit.

4.2 Collection

When full, or at the end of each day's production, these totes would be brought to a central loading area. Depending on the wastes produced, they could be picked up occasionally, but most would be serviced daily. Clean totes could be dropped off as the full ones are picked up.

4.3 Process Concept

The totes or palletted waste products would be received at the plant's loading/unloading bay and removed by forklift onto a weigh scale (see Figure 4.1). A primary separation step would follow in which the outer packaging material, such as boxes (wood, cardboard), plastic and paper wrapping, etc., would be removed and placed in storage bins. The grade of material being satisfactory, it would be baled and sent to the appropriate recycling company. The pallets would be reused or, if broken, sent out for recycling.

The individually packaged foods taken from either the totes or the primary separation step would then go through a variety of simple process steps, depending largely on the packaging material.

t

Materials would be processed in homogeneous batches. For example, different dairy products packaged in waxed cartons would be processed together. Similarly, dairy products in plastic film would be processed together. Beverages would be processed separately, and, again, according to packaging.

Each batch would be placed on a roller conveyor which would carry the packages over cutting blades, allowing the food/drink product to drain into a collection trough located under the conveyor. The packaging material would then be fed into a shredder which would tear it into strips approximately 2.5 centimeters wide. In many cases, it may be possible to go straight to the shredder without passing through the initial guillotine step on the conveyor.

One of the shredders which is being considered is shown in Figure 4.2. It incorporates shredding, washing and dewatering stages in a single piece of equipment, discharging the food product and recyclable packaging materials into different containers.

Liquid food product would be pumped to one of two storage tanks. An option which will be considered, as the business gets under way, is the use of tanker trailers as the final product storage facilities, thereby avoiding the initial cost of installing large storage tanks. However, it is unlikely that this option would be economical in the long-term. The packaging from this operation would be combined with the recovered outer packaging into the various grade bins. When sufficient quantities have been collected, the material would either be baled or compacted and brought to the appropriate recycler.

Fruits and vegetables would require pulping. All packaging would have to be recovered manually. This would include tasks like the removal of shrinkwrap from produce such as tomatoes, cucumbers, etc., or the opening of large bags of potatoes. Bulk quantities of produce would be fed to a pulper. Here, they would be comminuted by high speed shearing blades into a pulp. Fruits with large pits, such as peaches, plums and mangoes, could be handled, but the pulp would require screening to remove pit fragments. The pulp could then be pumped to a storage tank.

Many food processors receive raw materials in plastic pails, the most common type being the 5 gallon size. These would be placed on a conveyor to undergo automatic washing. The cleaned pails could then be used for services other than food handling. Damaged pails would be shredded and the plastic sold for recycling. Other recyclable containers to be cleaned and recycled include fibreboard barrels and steel drums. Many of the drums used in the food industry are the one way type (gauge No. 14), being too thin for repeated service. One company considers these drums its biggest disposal problem. To be landfilled, they are required to remove the ends from each drum. Each end takes about 10 minutes to remove, a very labour intensive task. BPI's process would quickly crush these barrels, which would then be sold to metal recyclers.

All emptied totes would be placed on a conveyor where they would be cleaned automatically and made ready for return to the processors.

Two food waste storage tanks would be required. One would contain dairy and related products such as milk, cream, yogurts, etc. These foods typically have high fat content, relatively high solids content, and are highly nutritious. The second tank would store the high water/high sugar content liquids such as pulped produce, fruit drinks and soft drinks. The proposed facility would handle up to 26,000 tonnes per year. Based on a 5 day work week, the daily capacity would be 100 tonnes, or roughly 50,000 litres for each of the two food types.

To handle unexpected emergencies such as special disposal or receivers unable to accept delivery, each tank would require several days' processing capacity. Thus, each must be approximately 100,000 litres. A suitable tank would be approximately 20 feet in diameter and 10 feet high. Since the food mixtures may have to sit in the totes for twenty four hours before collection and the again in storage following processing for another twenty four hours, a refrigeration system would be required for each tank. This would require the ability to cool the temperature down to 3°C, and maintain it at that temperature during all seasons. This would involve a recirculation pump to keep the mixtures mixed and an in-line refrigeration unit. St. Lawrence Starch (SLS), a potential receiver (see 5.0 Market), expressed concern that low temperature storage may cause pumping difficulties. Their glucose mixtures require heating to 37°C to be pumpable. However, heating to such temperatures would hasten spoilage of the mixtures and cause protein and vitamin degradation. To investigate this matter, a sample mixture was blended (see Appendix B "sample mixture") to test viscosity. The results show the viscosity at 23°C was approximately 100 cp and, at 5°C, was 250 cp. Pumping problems are not expected for fluids in this viscosity range.

High power vacuum trucks would be required to transport the reprocessed food mixtures. Capacities can range from 18,000 to 45,000 litres (5,000 to 10,000 gallons). They would be loaded by drawing the liquid into the tank by the vacuum. To unload, the process is reversed and the slightly viscous liquid is blown from the tank. This system will work to fill up tanks or farmers' feed troughs.

It is planned to operate the facility 5 days per week, amd clean all processing and storage equipment over the week-end.

4.4 Plant Cost Estimate

Shown in Table 4.1 is a preliminary cost estimate for the plant equipment and services. However, all items are not necessarily needed initially. For example, the carousel and hammermill for the glass packaged products would probably be the last facility to be installed, since the equipment would likely require some modification and the products themselves would not be a priority market. It may also be more economical to employ compactors instead of a baler for the packaging waste. Because the plant would be built beside other BPI facilities, it is assumed that steam would be available for the washing operations.

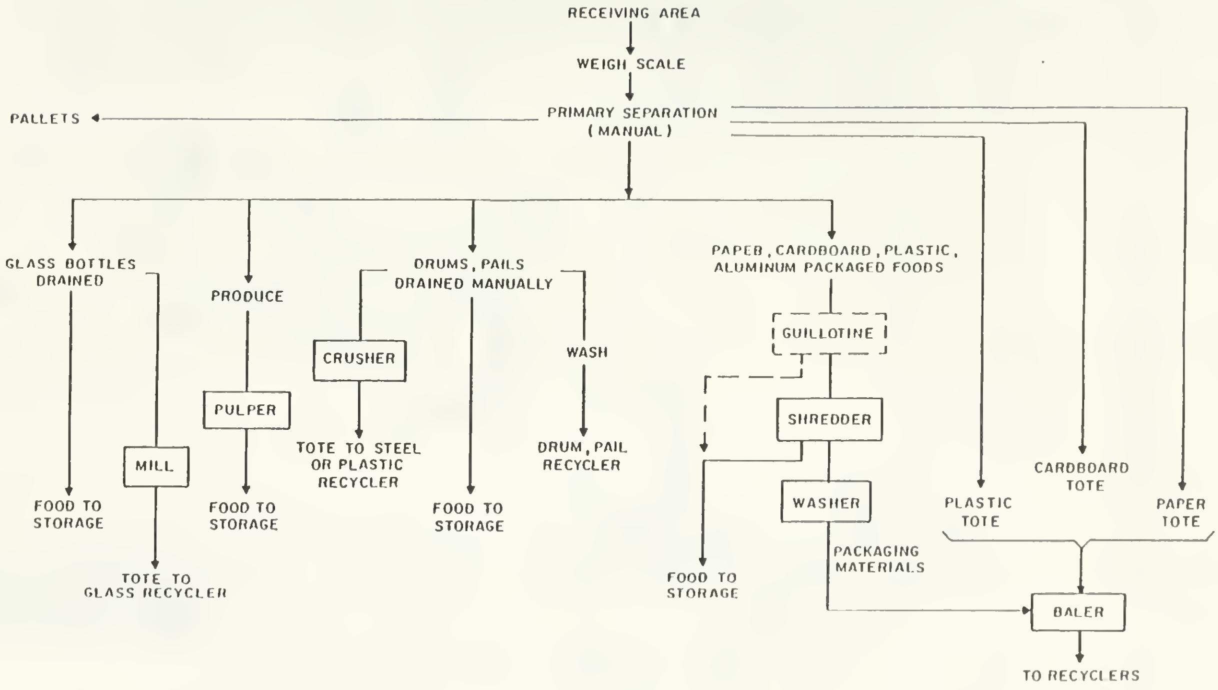
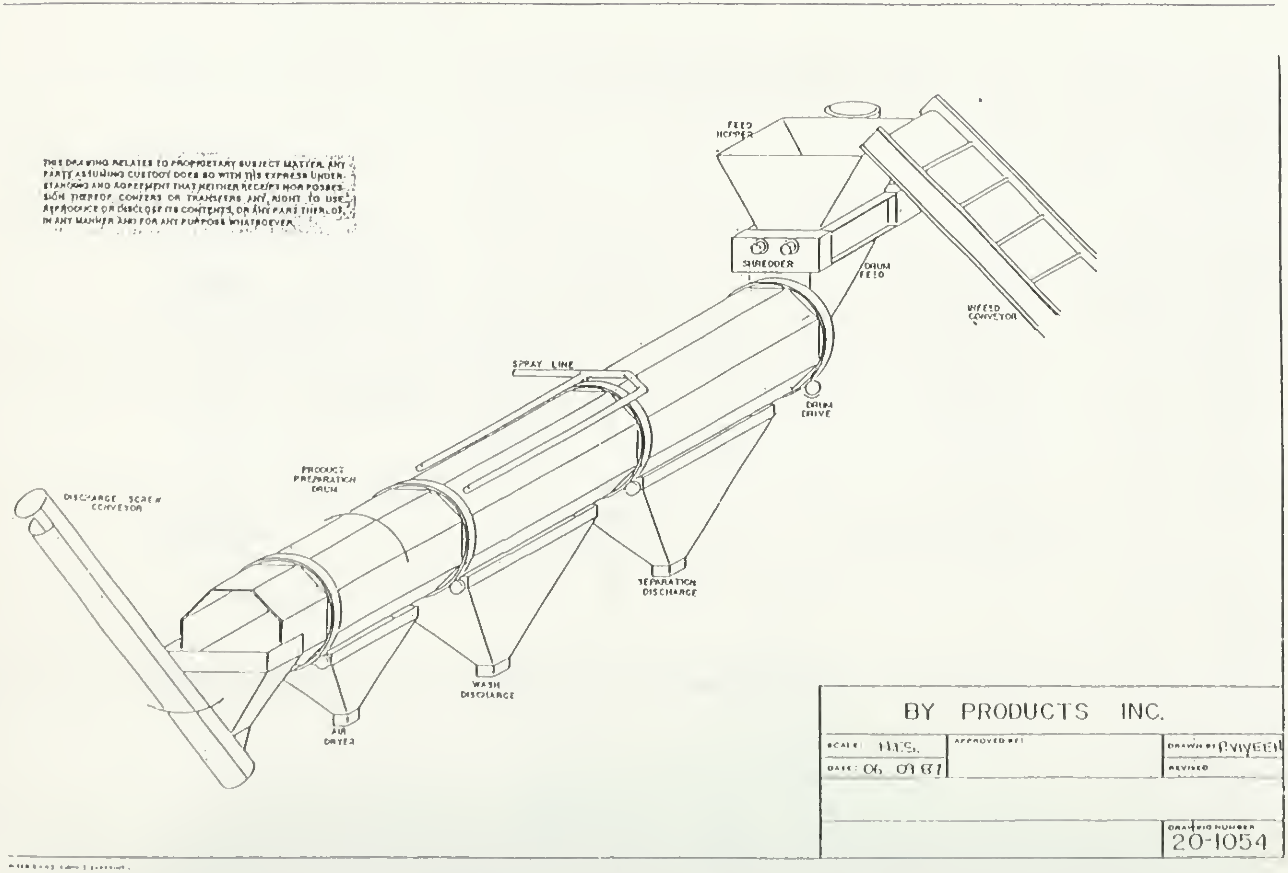


FIG. 4.1 PROCESS FLOW DIAGRAM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DISCHARGE SCREW CONVEYOR
SEPARATION DISCHARGE
WASH DISCHARGE
AIR DRYER
BY PRODUCTS INC.
SCALE: N.T.S.
DATE: 06 03 87
APPROVED BY:
DRAWN BY: P.VIYEEN
REVISED
DRAWING NUMBER
20-1054

FIGURE 4.2 - Waste Processing Machine

TABLE 4.1 - Preliminary Budget for Proposed Depackaging/ Recycling Operation

Equipment	Cost ($1987 Cdn)	Note (see App. C)
Storage Tanks (2)	18,000	1
Refrigeration System	26,000	2
Low End Shredder	60,000	3
Medium End Shredder	70,000	4
Carousel & Hammermill	15,000	5
Drum Crusher & Plastic Shredder	30,000	6
Plastic Granulator	10,000	7
Compactors (3) & Containers (3)	60,000	8
Pumps (3)	8,000	9
Weigh Scale	5,000	10
Pulp & Dewaterer	24,000	11
Conveyors, Chutes, Miscellaneous Handling Equipment	25,000	12
Totes - 20 @ $1,000 each	20,000	13
Purchased Equipment Cost	371,000	
Piping	23,000	14
Electrical	37,000	15
Engineering	28,000	16
Building Lease	12,000	17
	471,000	
Contingencies (12.5%)	59,000	18
Total Cost	530,000	

5. MARKET FOR RECOVERED MATERIALS

5.1 Packaging Materials

The four main types of packaging material are plastic, paper products, aluminum and glass. The first three are often found in combination with each other. There is an established recycling industry for these materials in Ontario. Some of the companies relevent to this study are listed in Appendix D.

5.1.1 Aluminum

There are several sources of aluminum wastes. One is the aluminum can used for soft drinks. Once the beverage has been removed, the cans are easily recyclable with a ready market. Clean cans are graded mill spec and fetch the highest price. A common container for items such as fruit drinks is the tetra-pack, a single serving coated paper carton with an inner plastic and foil liner. The cartons contain approximately 7% by weight aluminum. Another source of aluminum is coffee creamer lids. Both the discarded creamer packages and the stampings which remain after the container is punched out can be collected. Depending on the manufacturer, these may contain from 5 to 18% aluminum. Bristol Industries accepts some aluminum laminates. They process the material by burning off any paper and plastic coatings. The remaining aluminum is separated from the ash and is returned to the aluminum mills. For such mixed wastes, they presently pay 60 cents per pound of aluminum. Currently, they are at full capacity so their minimum acceptable aluminum content is 10%. Therefore, at the moment, they will not accept the tetra-pack containers or certain types of creamers. However, potentially, they are in the market for this material, as are Best Way Recyclers of Pickering. The price of mill spec aluminum cans, that is clean cans that can be returned directly to the aluminum mill, is 87.5 cents per pound.

5.1.2 Plastics

Plastics are becoming the food packaging material of choice. They are versatile, light, moisture and air impermeable, and relatively inexpensive with high consumer acceptance. The use of plastics has grown from 1.8 billion pounds in 1966 (Lederman, 1974) to 14.7 billion pounds in 1987 (Basta 1987).

There are two types of plastics: thermosets and thermoplastics. Thermosets are generally not recyclable. Fortunately, thermoplastics, which make up the greatest portion of consumer plastics, are recyclable.

There are several types of thermoplastics used in the food industry. Low Density Polyethylene (LDPE) is used for bread bags, milk pouches and outer bags and pallet stretch wraps. High Density Polyethylene (HDPE) is used to make containers such as margarine and sour cream tubs. Other plastics used are polypropylene as a film for snack foods and candy, and cellophane as an overwrap. Each 4 litre milk bag has approximately 33 grams of LDPE. The market for plastic is very unstable. Also, much research is being conducted into finding uses for mixed plastic wastes. At present, to realize the highest price, the different grades should be segregated and LDPE films should be further separated into clear (i.e. stretch wrap) and printed (i.e. most food wraps). Best Way Recycling quoted a price of 10-12¢/lb for 10,000-15,000 lb baled loads.

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5.1.3 Paper Products

Although replaced in many applications by plastics, paper is still the most common food packaging material. The newest forms combine paper with aluminum or plastics and these are known as laminates. The paper provides a rigid structure to the containers while the aluminum or plastic provides the oxygen and moisture impermeability. Also very common are the polyethylene coated paper products such as milk cartons. Each 1 litre milk carton has 34 grams of coated paper. The 500 mL size has 20 g. For these wastes, paper represents 3.8% and 3.3% of the total weight respectively.

Another important paper product waste from a quantity aspect is corrugated cardboard. It is often used in the shipping of goods. Therefore, a company may receive cardboard when receiving supplies, or may generate waste packaging when shipping its own products. It is quite costly to dispose of cardboard. It does not compress or pack well, which means more frequent trash pick-ups. One large dairy plant was able to reduce its trash pick-ups from two or three times per week to once per week by segregating the cardboard which is now picked up free of charge. However, recyclers are usually only interested in picking up from large generators. There appears to be no interest in picking up smaller volumes on a regular basis.

Also common is kraft paper. Paper bags are the most familiar example of this type. Again, this material does not compact well and is, therefore, expensive to dispose.

There is a huge demand for recycled paper. In 1984, 100,007 tonnes of waste paper were exported at a value of $153.94 per tonne. However, 605,168 tonnes of waste paper were imported to meet demand, valued at $187.22 per tonne. This represents a negative trade imbalance of 505,161 tonnes, worth $87.3 million (Recoup's Canadian Recyclers Directory, 1985).

The value of the paper wastes depends on its composition which can vary greatly. A representative for Domtar Packaging, Recycling Division, reports there are up to 99 different paper grades. Clean kraft paper is highly valued and fetches about $400.00 a tonne. Corrugated cardboard is worth $80.00 per tonne baled, or $60.00 per tonne loose. On its own, material such as waxed or polyethylene coated cartons is not recyclable at Domtar, but, when mixed with other papers into a mixed paper grade, it is valued at about $20.00 per tonne. However, Wray Fibres International is interested in buying coated papers once they are baled and available in truckload quantities (36,000 lbs).

5.2 Food Materials

Food will represent the largest portion of recyclable material, approximately 95% to 99% by weight of the waste processed. Several options exist to utilize the recovered food. Composting is a very common method of waste disposal in Europe and is becoming more so in North America. Composting is the use of decaying organic matter as a soil conditioner. It fertilizes the soil and reduces runoff and wind erosion. It can be used on a large scale, such as vineyard slopes, or on a small scale, such as a homeowner's garden and flower pots. Food wastes would provide an easily decomposable material. However, much of the packaging would still have to be removed. Glass, metal and plastics do not decay, and paper, especially waxed and laminated papers used in the food industry, do so only slowly. A study into the decomposition of paper waste in landfills reported that "core samples from the fill have shown legible newsprint over a decade old, supporting the hypothesis that a substantial fraction of the material is not effectively biodegradable" (Augenstein, D. C., et al, 1976).

Composting is primarily a waste disposal process to reduce the volume of material being landfilled. Typically, it is being used in densely populated areas to deal with biodegradable matter such as lawn trimmings and leaves. In San Mateo, California, "where 'topsoil' is a manufactured product in short supply", it has a market value of U.S. $9.00 per tonne (Bergeron, 1988).

To provide good quality mulch from the food wastes, all non-biodegradable materials must be removed prior to mulching. To decompose the remaining food and apply it to the ground to grow more food seems an inefficient process, if it could be used directly as animal feed. Of course, feeding food scraps to livestock is not new. Traditionally, large swine herds were raised near major cities, such as New York, Philadelphia and Los Angeles, to consume household and commercial wastes. Until 1950, farms located in New Jersey serviced New York City.

Following World War II, extensive research was conducted into the replacement of livestock grain, which was in short supply then, with food wastes (Baird, 1973). Recent research has tended to concentrate on institutional food wastes, such as scrapings from plates in restaurants, cafeterias and military bases. Typically, the food scraps and preparation wastes are emulsified. They are then dehydrated and either sterilized prior to being passed through an extruder, or sterilized by the extrusion process. Food additives, such as grains, may or may not be included. The resulting product is "palatable to pigs, highly digestible, high in energy and generally adequate nutritionally" (Baird, 1973).

The most likely market for food waste is swine feed. The nutritional requirements for swine are very similar to human needs, for which the food was originally intended. A recent study indicates that some food wastes were low in pantothenic acid (vitamin B_3, easily destroyed by heat, a dietary essential except for horses and ruminants [Merck Index]), while others were low in phosphorus, manganese and calcium (A. T. Price, 1985). Institutional wastes and those studied in this report would likely be very similar, meat proteins being considerably less, but highly digestible dairy proteins being significantly higher in the latter. The cooking of the food waste is a likely reason for its low pantothenic acid content. Meat waste must be cooked to prevent the transmission of trighinosis to swine. Wastes containing large amounts of milk, which is an excellent source of vitamins and minerals, would likely not show the same phosphorus and calcium deficiencies.

Because of the high water content of food wastes (70 to 90 percent) compared to grains (10 to 20 percent), swine must consume 4 to 5 times as much food waste. This works out to about six to seven tonnes per hog to bring to market weight (Price, A. T., 1985). Of course, there is a physical limit to the amount of food waste a pig can consume. Therefore, this material is not suitable for pigs below 60 pounds. Although moisture removal would reduce transportation costs, and so be desirable, it is not required as far as the dietary requirements for grower and finishing swine. In an investigation into liquid feeding of pigs involving 44 experiments, "one third showed no differences between the two systems", and "if wet feeding is practised, then any ratio of water to dry food between 1.5:1 and 4:1 will be unlikely to affect performance." (Miloslav Rechcigl, Jr., 1982). If the wastes are fed as is, a facility processing 26,000 tonnes per year of food waste would provide enough food for 4,000 pigs.

This extent of processing would require incoming waste streams of consistent composition and volumes. Initially, established feed mills are the best market for the recovered food wastes. Their high production rates can guarantee feed consistency vital to livestock management.

St. Lawrence Starch, established in 1889 and producers of corn gluten feed, has expressed great interest in accepting this mixture as nutritional supplement in its feed products. The company currently has excess processing capacity. The ideal product would be 40-55% solids, though a minimum of 15% is acceptable. The amount of protein and fat (profat) desired is 27%. Nutritional information for milk shows whole milk has up to 55% profat on a dry basis and skim milk has 38% profat on a dry basis. Fruits and vegetables generally have trace amounts of fat, but the protein values range from a low of 0.2% (wet basis) for pears to 2.1% (wet basis) for potatoes, with a high of 21.4% (wet basis) for beans.

Negotiations are currently in progress between BPI and St. Lawrence Starch to settle prices and arrange for holding tanks.

Pet food producers were also investigated as a potential market. The interest shown was slight. Most formulations are meat based, with cat food containing exclusively meat, and dog foods containing a limited amount of filler. The pet foods also generally use "fresh" ingredients to better control quality. However, Ralston Purina of Woodstock would be willing to investigate using dry products if consistent quality and volumes can be guaranteed.

An important aspect of recycling food products is security, both in regard to those generating, and those receiving the products. Large brand name companies are very concerned with the ramifications of off-quality products, destined for disposal, finding their way back into the marketplace. One confectionery company ensures labels are destroyed on all products destined for disposal. These concerns must be alleviated before companies will trust BPI to handle disposal of off-quality food.

Ensuring prompt reprocessing of incoming food, with the possibility of a company representative (e.g. its truck driver) viewing the processing, should settle these concerns.

Those accepting the reprocessed food for animal feed will also be safety conscious. Contamination of food supplies could be injurious to the animals and humans who consume them.

Close control over incoming shipments will be vital. Dealing with only known manufacturers and food types will simplify quality control. The emphasis of the operation should be changed from waste disposal to recycling. Generators may be less likely to accidentally or intentionally dispose of hazardous material through BPI if it is known the products will be recycled rather than simply landfilled.

Legal safeguards, in the form of contracts placing the onus on the generator to ensure deleterious materials are not included, may be required.

One advantage of supplying a large processor, such as St. Lawrence Starch, is that any such deleterious material that does slip through the safeguards will be found in only minute quantities after processing through SLS.

6. RELEVANT REGULATIONS

The proposed facility falls under the jurisdiction of two agencies: the Ministry of the Environment (MOE), and Agriculture Canada.

MOE has jurisdiction over waste handling facilities. Regulation 309, which came into effect in September, 1986, deals with all hazardous and liquid industrial wastes. Wastes covered by this require registration and manifests for each shipment. There are several exemptions which may apply to food waste. The first is the exemption for recycled materials.

Generally, to qualify under the recycling exemption, the recycling must be done for purposes other than waste management. This can be determined by reviewing the viability of the operation without the incoming waste material. Clearly, BPI's process depends on managing other people's wastes and, therefore, cannot claim a recycling exemption. The other exemption is for liquid industrial wastes. The regulations state that "wastes that result directly from food processing and preparation operations, including food packaging, food preserving, wine making, cheese making and restaurants" (Reg. 309, section 38, part vi) are not included under the regulations. Thus, BPI's facility, which will be treating such food wastes, should not require registration or manifesting of shipments.

Agriculture Canada regulates the production of livestock feed under the Federal Feeds Act. This ensures that the livestock remain healthy so that humans who eventually consume animal products do not pick up any deleterious substances. The Feeds

Act specifies the kinds of ingredients which may be included in animal feed. Ingredients mentioned are dehydrated bakery wastes, dehydrated apple pomace, dried potato waste meal, and dried skim milk. Other ingredients listed are typical livestock feeds, such as grains. The Act also requires nutrient guarantees specifying the levels of nutrients, such as Vitamins A, D and E and minerals such as potasium, sodium, calcium, selenium, iodine, etc. (Appendix E, Table 4, Feeds Act). The significance of the list is that feeds containing other ingredients must be approved by the director of the Feeds and Fertilizer Division. A typical food stream from BPI's facility would be a mixture of fluid milk, juices, and pulped vegetables. Only a few of the vegetables are listed and then only in a dehydrated form. Thus, the mixture would require registration to be sold as an animal feed. All these food wastes would be suitable for animal feed and would likely be a very nutritious swine feed. Thus, approval based on nutritional value would likely only be a formality. However, the Act also requires consistent composition. Livestock require consistent food sources because they take time to adapt to particular feeds. If this criterion cannot be guaranteed, registration may not be granted. A load may contain whole milk and potatoes one day, producing a very nutritious pulp; however, the next waste may be composed of only lettuce and watermelon, producing a pulp inadequate as a livestock feed.

Although these fluctuations may not arise, and the resulting feed stream be relatively consistent, initially, no nutritional guarantee can be determined.

An Agriculture Canada representative indicated small scale producers might avoid federal interference where the exchange is between individuals such as the present practice of farmers collecting dairy wastes. In such cases, it is assumed to be the farmer's responsibility to ensure the feed is adequate for his livestock needs. Large scale commercial operations would be required to follow the Act, though, admittedly, there is a fine line of distinction between the two cases.

The best course of action would be to write the director's office detailing the proposed operations. Information to be included would be: likely foods to be handled; nutritional information; volumes expected; and measures taken to ensure the food is fit for animal consumption. The financial nature of the exchange should also be included, i.e. will the feed be given to farmers; will they be required to pay the cost of handling; or will the transaction be expected to make a profit. Even feed given free to farmers is regulated, since the Act applies to feed imported, sold or manufactured in Canada. This information can then be sent to:

Linda Morrison, Associate Director Feed Evaluation,
Feed and Fertilizer Division,
Agriculture Canada,
960 Carling Avenue,
Ottawa, Ontario
K1A 0C6

Telphone No: (613) 995-7900

This should allow Agriculture Canada to make recommendations regarding the operation, and permit BPI to supply directly to the farmers until BPI becomes officially registered, without violating the Act.

Ontario Ministry of Agriculture and Food have no regulatory interest in the area of animal feed. Obviously, the plant itself would be expected to comply with the local air and water emission by-laws.

7. CONCLUSIONS

1. The response to the survey questionnaire was less than expected. Nevertheless, those who responded indicated a total annual food/packaging waste generation rate of 5,800 tonnes. Added to this is the 3,930 tonnes of waste generated by the Ontario Food Terminal. The companies who responded represented 2.8 percent of total number of manufacturing operations in the Toronto-Peel-Halton region. However, from those operations who responded, approximately 10,000 tonnes of waste or 40 percent of the proposed 26,000 tonnes/year plant capacity have been confirmed. There is likely more than a sufficient volume of waste generated by the industry in the region to supply the proposed plant.

2. St. Lawrence Starch Co. expressed a keen interest in taking BPI's 'food' product, and indicated that they would be willing to enter into a term contract with BPI to take it. The product would also have value and demand in direct animal feed applications for farmers.

3. Both the waste supply and reprocessed product market for BPI look good. However, the economics and profitability of the proposed facility will depend on the distribution of charges between the waste generator and the recovered product end-user or recycler. BPI will have to provide a significant financial incentive to the generator to encourage him to use the facility. The two alternatives which BPI will have to overcome to do this are:

   (1) the continuation of the current waste disposal system of landfilling/farmer pick-up, and

(2) the establishment of in-house recovery facilities at the waste generator's plant.

It is felt that BPI should not rely totally on the generator for the income to run the business, since they may have to be considerably cheaper than other options to ensure supply. The perceived advantages and disadvantages of the facility are summarized in Table 7.1.

4. There would appear to be a niche in the waste management industry for BPI's proposed facility. Economic factors associated with waste management are forcing generators to search for cheaper alternatives to current practices. Companies already involved in the recycling industry have managed to provide a sufficiently attractive alternative to the landfilling of waste paper, cardboard, aluminum, plastics, steel, etc., for generators, and, at the same time, presumably remain profitable. There is no doubt that the facility would be environmentally desirable, and would ease the demands on all levels of government for increased landfill capacity.

5. Detailed engineering design work would be required prior to equipment purchase and plant construction.

TABLE 7.1 - Summary of Advantages and Disadvantages of Proposed Facility

	Advantages
Waste Generator	Would provide a cheaper alternative to landfill
	Would provide regular and reliable waste collection/disposal service
	Would eliminate cost of depackaging food for those plants presently serviced by pig farmers
	Would provide outlet for items which are difficult to dispose, such as drums
	Would eliminate labour required for compacting waste
Pig Farmers/Animal Feed Processors	Would be a central waste collection and processing facility which would make waste pick-up easier
	Bulked waste foods from several sources should provide more consistent waste volumes and composition
Environment	Less waste would be sent to landfill
	Less waste would be discharged to sewer or watercourse
	Valuable material would be recycled, conserving valuable resources
BPI	Expands company's business activities
Recycling Industry	Would provide new sources of materials which were previously uneconomical to collect and reprocess
Government	Would help extend landfill life
	Would promote recycling
	Would provide employment

Table 7.1 (Contd.)

	Disadvantages
Waste Generators	Would have to pay for removal of wastes, some of which are currently being picked up free
Pig Farmers	May have to pay more for feed.

8. RECOMMENDATIONS

1. BPI should construct the plant in phases. The first phase might include the installation of equipment to process all wastes from one industry sector, preferably dairy. This does not necessarily prevent the processing of other industry waste, with the same equipment. At the same time, they should enter into negotiations with all major dairy processors to establish waste pick-up agreements, and with St. Lawrence Starch to set up delivery arrangements for the reprocessed food product. Storage facilities at the generators' plants and at St. Lawrence Starch should also be discussed.

2. Dairy wastes should be the first wastes processed. They are available, easy to handle and will generally contain only paper or plastic packaging. Once collection, storage, processing and distribution systems have been established for these wastes, then BPI could begin to expand into similar products, such as juices/soft drinks, which would be packaged with similar materials.

   The next expansion phase would probably be fruit and vegetable processing, followed by canned foods. The last area in which BPI should get involved is glass, which would require some special handling. The variety of glass containers in terms of shape and size would probably require some very sophisticated depackaging equipment. There exists a high potential for glass contamination of the food mixture which would be due to problems in either the generating plant or BPI. Quality control would require special attention.

3. BPI must establish a pricing system which will cover costs and satisfy its clients. Because this will likely be done on a trial-and-error basis initially, it is important to minimize the number of variables involved. Haulage arrangements must be worked out. Will trucks, skips, totes, compactors and tankers be purchased, leased or rented, and how many will be needed? A true understanding of these requirements will evolve once client agreements have been made.

4. Since the food product would be used in animal feed, BPI would have to establish adequate quality control procedures throughout the plant. Security would have to be tight to ensure that any off-spec products sent to the facility are all processed.

5. An objective of BPI should be compliance with the Feeds Act.

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APPENDIX A: Questionnaire and Letter of Introduction

Waste Production Questionnaire

General Information

1. Company Name: ______________________________

Location: ______________________ Telephone No.: ____________

2. Food Products: (List Specific Types)

Dairy: ______________________________

____

____

Cereal: ______________________________

____

____

Beverage: ______________________________

____

____

Fruits and Vegetables: ______________________________

____

____

Confectionary: ______________________________

____

____

Edible Oils: ______________________________

____

____

Other(s): ______________________________

____

____

Waste Profile

for each food waste)

1. Waste type: ____________________

2. Total amount of waste produced ____________________ (per week)

% Bulk ____________________ % Packaged ____________________

3. Reasons for disposal

- Off spec production: ____________________ %
- Past shelf life: ____________________ %
- Process start-up: ____________________ %
- Discontinued line: ____________________ %
- Other(s)*: ____________________ %

*Explanation: ____________________

4. How regular is waste production?

Daily: ____________________

Weekly: ____________________

Monthly: ____________________

Irregularly: ____________________

5. How is waste collected and stored?

A. Bulk ____________________

____

B. Packaged ____________________

____

6. How is waste depackaged and disposed?

(e.g. landfilled, municipal sewer, on-site treatment): ____________________

____

7. How often is waste disposed? ____________________

January , 1988.

:

By-Products Inc. have retained ORF to conduct a feasibility study into the establishment of a food waste recycling facility in the Toronto area. As I am sure you are well aware, the cost of landfilling or sewering waste these days is increasing rapidly and, therefore, less costly alternatives to waste disposal are always desirable. However, prior to building a facility, we need to establish some basic data such as volumes, packaging type, current in-plant collection system, etc., on the waste (including off-spec product) being generated. For this reason, we are asking you to take a little time to complete the attached survey questionnaire as accurately as possible. The economic benefit of the proposed facility to the food industry in the future will justify the time spent. All information provided to us will be treated as confidential and will be available only to our client.

We also intend visiting a number of companies to get a better understanding of the needs in each of the food industry sectors. Indeed, should you prefer this form of participation, please let us know.

A stamped addressed envelope to return the completed questionnaire is enclosed for your convenience. We would appreciate if you could return the completed questionnaire to us as soon as possible.

Should you have any questions concerning the project, please feel free to contact either Peter Top or myself.

Thanking you in advance for your co-operation.

Yours very truly,

Brian Forrestal, P.Eng.
Manager
Waste Treatment Technology
Energy & Environmental
Engineering Division

BF/id
enc.

APPENDIX B: 'Typical' Sample Composition and Viscosity

From the data obtained, the following volumes of wastes have been identified, and could potentially be sent to BPI for disposal.

TABLE B.1 - Identified Waste Groups

Food	Quantity Produced (Tonnes/week)	% of Total Identified
Milk	79.3	39
Produce	76.0	38
Water*	24.0	12
Juices	10.0	5
Dairy By-Products	7.4	4
Ice Cream	3.1	2
Vegetable Oils	2.1	1
Sugars (dextrose, glucose, etc.)	2.1	1
Total	204.0	100**

* added from equipment washing, etc.
**does not add up to 100% due to rounding

From this, a sample mixture (see Table B.2) was blended.

TABLE B.2 - Sample Feed Mixture

Food	Quantity Produced (grams)	% of Total Mixture
Milk	400	37
Produce		
Carrot	103	10
Potatoes	180	17
Lettuce	41	4
Apple	153	14
Water	50	5
Juices	100	10
Dairy By-Products	47	4
Total	1073.7	100**

This mixture was then analyzed for viscocity and moisture content.

At 23°C, viscosity was approximately 100 centipoise
at 5°C, viscosity was approximately 250 centipoise

Moisture analysis gave readings of 85.6% and 85.5% H_2O

This is very close to the value obtained by using published information on moisture content of single ingredients.

APPENDIX C: References for Cost Estimate

Notes for Preliminary Cost Estimate

1. Based on 100,000 L nominal capacity + 20% over-capacity, FPR field erected.
   Cost $9,000 each
   (Chemical Engineering Magazine, p 144, 1984)

2. Refrigeration system cooling 12 tonnes/day of water from 25°C to 3°C.
   (Perry's, p 25-76, 1984)

3. Low-end Shredder - Capacity 2 tonne/hour
   Price Quote from Ron Beach, Beach Equipment

4. Medium End Shredder
   Price Quote from Ron Beach, Beach Equipment

5. Carousel + Hammermill
   Price Quote - Joe Monteith, BPI

6. Drum Crush and Plastic Shredder
   Price Quote from Ron Beach, Beach Equipment

7. Plastic Granulator
   Price Quote from Ron Beach, Beach Equipment

8. Compactors and Containers - 3 units
   One for garbage; one for paper; and one for plastic
   Price Quote from Ron Beach, Beach Equipment

9. Pumps: Centrifugal - 3 required
   Capacity 165 gals/min
   Cost $2,600 each
   (Chemical Engineering Magazine, p 119, 1984)

10. Weigh Scale
    Capacity 5,000 lbs
    Price Quote from Toledo Scale

11. Pulper and Dewaterer
    Capacity 900 lbs/hr
    Price Quote from Somat Corporation

12. Conveyors, Chutes, Miscellaneous Handling Equipment
    Price Quote from Ron Beach, Beach Equipment

13. Totes, - 20 required
    Cost $1,000 each
    Price Quote from Joe Monteith, BPI

14. Piping Cost - 31% of purchased equipment cost
    (Peters & Timmerhaus, pp 170-175, 537, 1980)
    [x 0.20 for using plastic piping and in-house installation]

15. Electrical Cost - 10% of purchased equipment cost
    (Peters & Timmerhaus, pp 170-175, 1980)

16. Engineering Cost - 30% of purchased equipment cost for liquids solids processing plant
    (Peters & Timmerhaus, pp 170-175, 1980)
    [x 0.25 for manufacturer's package units]

17. Building Lease - 10,000 ft^2, 3 month construction phase
    Price Quote from Joe Monteith, BPI

18. Contingencies estimated at 12.5%
    (Chemical Engineering Magazine, p 90, 1984)

References

Chemical Engineering Magazine. Modern Cost Engineering Methods and Data. Volume II. McGraw-Hill Publishers, New York, 1984.

Robert Perry and Don Green. Perry's Chemical Engineers Handbook. McGraw-Hill Publishers, New York, 1984.

Max S. Peters and Klaus D. Timmerhaus. Plant Design and Economics for Chemical Engineers. McGraw-Hill Publishers, New York, 1980.

APPENDIX D: List of Recycling Industries in Ontario

Paper Products

Domtar, 66 Shorncliff, Toronto, Ontario M8Z 5K1
(416) 231-2525
Corrugated cardboard, boxboard, mixed papers

Aluminum

Bristol Metal Industries of Canada, 252 Unwin Avenue, Toronto, Ontario
Cans, bottle caps, laminated foils

Alcan, P.O. Box 269, Toronto Dominion Centre, Toronto, Ontario M5K 1K1
Mill grade cans

Best Way Recycling, 1452 Rose Bank Road, Pickering, Ontario L1V 1T4
(416) 839-7764
Laminated foils, cans

Plastics

Galvano Plastics, 544 Aberdeen Avenue, Woodbridge, Ontario L4L 4L6
(416) 851-8109
Thermoplastics, mixed or separated

R & D Plastic Technologies Inc., 7650 Kimbel Street, Unit #22-27, Mississauga, Ontario L5L 1L2
(416) 673-8269

Glass

Rosen Cullet, P.O. Box 188, Kitchener, Ontario N2G 3P3
(519) 456-0309
Bottle and glass recyclers

Holtz & Sons Co., 166 Ferguson Avenue North, Hamilton, Ontario
L8L 4Y4
(416) 527-9266

Pallets

MultiPallet Ltd., 954 Middlegate Road, Mississauga, Ontario
L4Y 1M3
(416) 270-7901
Pallet Recycling

Premier Pallet Repair Ltd., 5819 Campus, Mississauga, Ontario
(416) 671-4441
Pallet Recycling

APPENDIX E: Nutrient Requirements - Feeds Act

TABLE 4

(S 5)

Range of Nutrient Guarantees for Complete Feeds¹ for Use in the Exemption of Feeds from Registration

	CHICKENS		TURKEYS		SWINE		DAIRY		BEEF		SHEEP	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Cobalt (mg/kg)	NRS	5	NRS	5	NRS	5	0.2	10	0.1	10	0.1	10
Copper (mg/kg)	4	125	6	125	6	125	20	100	4	50	NRS	8 (added)
Iodine (mg/kg)	0.4	10	0.4	10	0 2	10	0.5	10	0.1	10	0.1(O) 0.8(LT)	10
Iron (mg/kg)	80	750	60	750	40(O) 80(B) 150(W)	750	100(S) 50(O)	750	10	750	30	250
Manganese (mg/kg)	55	500	55	500	10	200	40	300	20	200	20	200
Selenium (mg/kg)	NRS	0.1 (added)	NRS	0.2 (added)	NRS	0.3(W) (added) 0.1(O) (added)	NRS	0.2 (added)	NRS	0.1 (added)	NRS	0.1 (added)
Zinc (mg/kg)	65	500	75	500	100	500	40	500	20	250	35	150
Calcium (%)	0 60(G) 0.90(S) 2.25(B) 1 25(L)	1 20(O) 4.00(L,B)	0 80(O) 2 25(B)	1.20(O) 4.00(B)	0.50(O) 0.75(LT,B) 0.80(PS)	1.00	0.40	2.00	0.18	2 00	0 21	2 00
Phosphorus (%)	0 40(G) 0.50(L,B) 0.70(S)	0.80(L) 1.00(O)	0.70(O) 0.80(S)	0.80(B) 1.00(O)	0.50(O) 0.60(PS)	1.50	0 30	1.00	0 18	1 00	0.16	0.60
Magnesium (%)	0 06	0.30	0 05	0.30	0.04	0 30	0.20	1 00	0.04(O) 0 18(LT,B)	0.50	0.04	0.50

Range of Nutrient Guarantees for Complete Feeds[1] for Use in the Exemption of Feeds from Registration (conc.)

	CHICKENS		TURKEYS		SWINE		DAIRY		BEEF		SHEEP	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Sodium (%)	0.15	0.80	0.15	0.80(O) 0.40(PS)	0.10(O) 0.15(B) 0.20(LT)	0.80	0.10(O) 0.18(LT)	2.40	0.06	1.20[2]	0.04	1.20[2]
Potassium (%)	0.2	2.0	0.4	2.0	0.2	2.0	0.8	3.0	0.6	3.0	0.5	3.0
Sulfur (%)	NRS	NRS	NRS	NRS	NRS	NRS	0.1	0.4	0.1	0.4	0.1	0.4
Vitamin A	1,500 IU/kg (O) 4,000 IU/kg (L,B)	20,000 IU/kg (O) 40,000 IU/kg (L,B)	4,000 IU/kg	40,000 IU/kg	1,300 IU/kg(G) 2,000 IU/kg(O) 4,000 IU/kg(B)	20,000 IU/kg	2,200 IU/kg(O) 3,200 IU/kg (LT,B)	200,000 IU/day	2,200 IU/kg(O) 2,800 IU/kg(DC) 3,900 IU/kg (B,LT)	100,000 IU/day	1,400 IU/kg(O) 3,000 IU/kg(LT)	75,000 IU/day
Vitamin D	200 ICU/kg (O) 500 ICU/kg (L,B)	5,000 ICU/kg	900 ICU/kg	5,000 ICU/kg	125 IU/kg(F) 200 IU/kg(O)	1,500 IU/kg	300 IU/kg	33,000 IU/day	275 IU/day	33,000 IU/day	150 IU/kg(O) 300 IU/kg(B,LT)	2,500 IU/day
Vitamin E	10 IU/kg	NRS	10 IU/kg(O) 25 IU/kg(B)	NRS	10 IU/kg	NRS	NRS	NRS	15 IU/kg	NRS	10 IU/kg	NRS

Footnote:

[1] For dairy cattle, complete feed refers to the grain ration

[2] The maximum for sodium does not apply to beef cattle and sheep feeds designed to be used to limit or regulate feed intake. A statement to the effect that adequate water must be provided shall be part of the directions for use

Abbreviations

B:	breeding
DC:	dry pregnant cow
F:	swine 60-100 kg body weight
G:	chicken 8-20 weeks of age turkey 8 weeks of age to market swine 20 kg body weight to market
L:	Layers
LT:	lactating
NRS:	no requirement specified
O:	others
PS:	turkeys 0-4 weeks of age swine 1-10 kg body weight
S:	chicken and turkey 0-8 weeks of age, calf starter
W:	weanling (swine up to 20 kg)